Cathodoluminescence as a tool in recognition of relations between components in the Cergowa sandstones (Oligocene, Outer Carpathians)

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The Cergowa sandstone is a prominent lithological complex in the Cergowa Beds (Lower Oligocene), which occur within the Dukla Tectonic Unit and the Silesian Tectonic Unit of the Outer Carpathians. The Cergowa sandstones were deposited in a deep marine basin by sediment gravity flows of high energy, which resulted in commonly massive structure, thick bedding and very low proportion of mudstone interbeds. These sandstones have outstanding physico-mechanical properties, which makes them one of the most valuable building materials mined in the Carpathians. A study by Peszat (1984) suggested exceptionally strong carbonate cementation of the detrital components as the reason for such exceptional technical parameters. On the other hand, the Cergowa Beds host six hydrocarbon fields known to date, and it is important to know the diagenetic alterations that control the Cergowa sandstones porosity and permeability. The cathodoluminescence (CL) with cold cathode, which was applied in this study, enables to detect diagenetic processes and visualize relationships between rock components. The CL images of the Cergowa sandstones mainly reveal luminescence colours in carbonates and feldspars, therefore these mineral groups were chosen to gain a better understanding of the diagenetic changes responsible for shaping of the present features of these rocks. This is the first time when CL analysis is applied to the Cergowa sandstones.

The CL analysis enabled the distinction of five generations of carbonate cement, labeled I, II, III, IV and V. They occur as pore-filling or replacing cements. Preliminary SEM analyses reveal that three generations are calcite (I, II, III), one is represented by dolomite (IV) and one by ferroan dolomite/ankerite (V). Based on geometrical relations and characteristic features of luminescence colours and intensities, the most probable sequence of carbonate diagenetic phases is proposed. Generation I and II is assigned to eo- and mesodiagenetic phase, generation IV to mesodiagenetic phase, generation V to more advanced mesodiagenetic stage and generation III to telodiagenetic phase.

Partial or total replacement of feldspars (and other silicate grains quartz and siliceous rock fragments/lithoclasts) by carbonate is a common diagenetic feature in the Cergowa sandstones, and appears as brown and orange zones in blue-green feldspar grains. Carbonate replacement areas appear mostly in marginal parts of feldspars and as elongated zones penetrating into the grains through fissures. Very highly advanced replacement results in patchy relics of feldspar within carbonate, and complete replacement results in carbonate pseudomorphs after detrital feldspar grains. Such complete replacement can be identified by comparing images analysed in CL with PL crossed-polarized light, the latter showing feldspar relics. PL plane-polarized light images are not useful in such cases. Dissolution and replacement of feldspars resulted from the influence of alkaline pore fluids. The intensity of dissolution and replacement ranged from moderate when mainly the marginal parts of grains were damaged by corrosion, to highly advanced when whole silicate grains were replaced by calcite. Despite variable intensity, this process was very important in sandstone lithification, by increasing surface of corroded grains and therefore improving contact with the binder. This resulted in

very strong cementation of the Cergowa sandstone components, what is manifested by their high hardness and resistance.

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Reference:

Peszat C (1984) Variations of mineral composition of the Cergowa sandstones in the light of their deposition conditions and diagenetic alterations (in Polish). Bull Pol Geol Instit 346/24:207–234